IWG2 has proposed that mobile units which operate with mobile-satellite systems utilizing any portion of the 1610-1626.5 MHz band shall limit their out-of-band emissions so as not to exceed an e.i.r.p. density of -70 dBW/1MHz averaged over any 20 ms period in any portion of the 1575.42 +/- 1.023 MHz band for broadband noise emission. For any discrete spurious emissions in the same band, i.e., bandwidth less than 600 Hz, the e.i.r.p. shall not exceed -80 dBW. IWG2 was not able to reach a consensus on out-of-band emission limits to protect GLONASS. Such out-of-band limits will be considered following a determination of whether the GLONASS frequency plan can be revised or reconfigured. The aviation community is in agreement that the same MES out-of-band emission limits of -70 dBW/1MHz broadband and -80 dBW narrowband (i.e., bandwidth less than 600 Hz) should also apply to any portion of the GLONASS operation band below 1610 MHz.

7.3.1. Principal Sharing Proposal For MSS And GLONASS. The principal sharing proposal by IWG2 is to reconfigure the GLONASS frequency plan to avoid co-frequency operation. The current GLONASS plan is to use 24 discrete carrier frequencies (one for each of the 24 satellites) in the 1602.5626 to 1615.5 MHz band. IWG2 proposes that the 24 operational satellites operate on only 12 carrier frequencies by assigning antipodal GLONASS satellites to the same carrier frequencies. No GLONASS performance degradation would result from this reconfiguration. Even allowing 14 carrier frequencies would permit GLONASS to operate below 1610 MHz, in the 1602.5625 to 1609.775 MHz band.

7.3.2. Impact of MSS Sharing with GLONASS. The sharing solution proposed by IWG2 would permit MSS operators to access the 1610-1616 MHz band. The proposed frequency reconfiguration plan would have to be accepted and implemented by the Russian administration. However, given the anticipated launch dates for the MSS systems, there is considerable time to explore this, and possibly other, sharing scenarios. If a sharing solution is not found, then it may not be possible for co-frequency operation to provide the level of protection to GLONASS that the aviation community has proposed to IWG2.

For reasons cited above, if the 1610-1616 MHz band cannot be used for MSS uplinks, the available uplink spectrum will be reduced by about 36% (6/16.5) under any band sharing approach. IWG2 has made no recommendation concerning out-of-band emissions to protect GLONASS. IWG1 believes that stringent out-of-band emission requirements may further reduce the available spectrum by requiring large guardbands.

7.4. Sharing with Services Other than Radio Astronomy and Aeronautical Radionavigation.

IWG2 concluded that systems in the L-band other than in the RAS and Aeronautical Radionavigation services are sparse and will not pose a sharing problem. However, there are systems and applications in the S-band that need to be considered in assessing the impact on MSS downlinks.

7.4.1. MMDS/ITFS. The Multichannel Multipoint Distribution Service/Instructional Fixed Service (MMDS/ITFS) uses twenty-eight 6-MHz channels in the 2500-2686 MHz band, adjacent to the MSS S-band allocation. IWG2 reports that there are about 500 MMDS/ITFS stations in the U.S., usually in urban and suburban areas. At one kilometer from the transmitter, MMDS yields a PFD of -72 $dBW/m^2/4kHz$ in-band, which is 70 dB higher than the maximum signal from any of the MSS downlinks in the neighboring MSS downlink band. The current MMDS/ITFS out-of-band emission level is -60 dB relative to carrier. At this level, MSS would experience serious interference within several kilometers of an MMDS/ITFS station. IWG2 recommends that the Commission restrict MMDS/ITFS out-of-band emissions from the lowest channel (in the 2500-2506 MHz band) to -90 dB relative to carrier. According to the IWG2 report, even this requirement would leave a zone of something less than 1.0 km around an ITFS transmitter in which a mobile terminal in the MSS will be interfered with seriously. IWG1 believes that MSS operators may have to selectively assign downlink channels to avoid any potential interference from MMDS/ITFS transmitters.

7.4.2. Industrial, Scientific and Medical Applications. The 2400-2500 MHz band is allocated to Industrial, Scientific and Medical (ISM) applications. The most prevalent use of this band is for microwave ovens. IWG2 reports that the estimated population of microwave ovens is 80 million in the United States and 200 million worldwide.

IWG2's analysis indicates that there may be an ISM interference noise floor in populated areas. MSS users in populated areas may experience levels of cumulative interference exceeding the thermal noise of the receiver.

To ameliorate any potential interference problem, IWG2 recommends that the Commission restrict the occupied bandwidth and tighten the permitted radiation from new microwave ovens.

Therefore, some MSS subscribers may suffer degraded or loss of service in some urban areas.

7.4.3. S-Band PFD Coordination Requirements. MSS/RDSS systems must coordinate with countries on whose territory the PFD exceeds the values specified in RR 2566. To the extent that this PFD limitation is relaxed, it may increase the available channel capacity and/or performance as indicated in Section 5.1.

8. ANALYSIS OF THE SHARING OPTIONS.

8.0. Policy Objectives.

8.0.0. In evaluating sharing options and technical rules for the proposed MSS allocation, Informal Working Group 1 ("IWG1") is guided by, and consideration must be given to, Section 1 of the Communications Act of 1934, the FCC's existing policies on U.S. licensed satellite systems authorized to provide domestic and international services, and the ITU Convention, to which the United States is a signatory.

8.0.1. The "basic touchstone" for the provision of satellite communications service is the mandate of Section 1 of the Act to regulate "interstate . . . commerce in communication by wire and radio so as to make available, so far as possible, to all people of the United States a rapid, efficient, nationwide . . . wire and radio communications service with adequate facilities at reasonable charges. . . ." 47 U.S.C. § 1; see Domestic Communications-Satellite Facilities, 22 FCC 2d 86, 94 (1970) ("DOMSAT"). In establishing policies and rules governing domestic satellite services to meet this mandate, the FCC has identified four specific objectives: (1) expedite the introduction of new technology and services; (2) afford reasonable opportunity for multiple entry; (3) facilitate removal of institutional restraints on system development; and (4) allow for incorporation of future technological advances. See Domestic Communications-Satellite Facilities, 84 FCC 2d 584, 586 (1980).

8.0.2. The FCC has recognized that multiple entry and competition among satellite system operators fosters these policy objectives by promoting market-driven services, cost-based charges, and technological innovation to improve service. See, e.g., Radio-Determination Satellite Service, 60 RR 2d 298, 301 (1986). This multiple entry policy has a direct bearing on the adoption of technical rules because the FCC should select "the system design which best assures that the benefits of a competitive marketplace are made available to ... users." Id.; see also Competitive Carrier, 85 FCC 2d 1 (1980).

In convening the MSS Above 1 GHz Negotiated Rulemaking Committee in CC Docket 92-166, the FCC described the Committee's work program (MSSAC-4) generally as to:

> Develop recommendations for FCC Rules in 47 C.F.R. Part 25 that address the technical aspects related to the selection and authorization of applicants to provide U.S. mobile satellite service (MSS) and radio-determination satellite service (RDSS) in the 1610-1626.5 MHz and 2483.5-2500 MHz frequency bands, and to

> the shared use of those bands by authorized entities....

The "Work program" of Working Group 1 of the Negotiated Rulemaking Committee (MSSAC-4) describes its general tasks to be to:

> Recommend modifications to the existing rules for these bands (47 C.F.R. § 25.141), or new rules as necessary, to maximize multiple entry and to avoid or resolve mutual exclusivity among the non-geostationary satellite applicants, and between proposed non-geostationary and proposed or authorized geostationary satellite systems, while maintaining economic viability of the systems....

It is thus clear that providing for multiple entry and a competitive marketplace are of paramount concern for the Committee.

8.0.3. Moreover, the need for international coordination of satellite systems has long been recognized as a part of U.S. radio communications policy, and the adoption of technical rules must be consistent with this policy. See DOMSAT, 22 FCC 2d at 94. Coordination is primarily achieved through procedures established by the ITU; for example, Resolution 46 for LEO satellites adopted at WARC-92.

8.0.4. In addition to these international coordination procedures, the United States, as a signatory to the ITU Convention, is committed to fostering the shared interests of all Administrations in planning use of spectrum resources. These interests include: (1) equitable access to the radio frequencies allocated for specific services for all Administrations; (2) efficient and economical resource utilization; (3) use of advanced technology; (4) uniform technical criteria for satellite systems; and (5) adaptability to the features of various Administration requirements and the needs of technological development and new services. See ITU Convention, Art. 33; Space WARC, 100 FCC 2d 976, 1000 (1985).

8.1. Criteria for Evaluation.

8.1.0. Based on Commission policy and public interest considerations, the following is an overview of the relevant criteria to be used in evaluating the various approaches for accommodating the MSS applicants seeking to utilize the 1610-1626.5 and 2483.5-2500 MHz bands. IWG1 believes that these criteria can be used to determine which approach will best serve the public interest.

8.1.1. The approach should maximize multiple entry.

8.1.2. Given the available frequency for MSS systems, any approach adopted by the Commission must allow for equitable access to the spectrum resource.

8.1.3. Because the bands must be shared with other services, the approach selected should not impose an undue burden on any licensee through the assignment of a particular frequency segment the use of which must be coordinated with other services.

8.1.4. The approach must be frequency efficient. In this regard, the approach that provides the largest overall channel capacity for multiple systems should be favorably considered.

8.1.5. The approach should allow systems to evolve so that licensees can upgrade their systems and integrate technological advances.

8.1.6. The approach should deter warehousing of the spectrum resource.

8.1.7. The approach must accommodate growth in demand.

8.1.8. Systems must have sufficient capacity to permit operation in an economically viable manner.

8.1.9. The approach should minimize administrative burden.

8.1.10. The approach should promote the successful completion of coordination among licensees.

8.1.11. The approach should allow U.S. systems to be coordinated internationally at the earliest possible time. At a minimum, the approach must not preclude the coordination and implementation of U.S. systems or other Administrations.

8.1.12. The approach should allow new entrants to be accommodated.

8.1.13. The approach should expedite implementation of MSS networks by U.S. companies.

While each approach should have as its objective the satisfaction of all of the foregoing criteria, the following are critical factors for evaluating the various approaches:

(a) Maximization of multiple entry;

(b) Potential aggregate capacity; and

(c) Facilitating new entrants, international and domestic.

The following section conducts an evaluation of the sharing approaches based upon these three criteria.

8.2. Evaluation of Sharing Approaches.

8.2.0. As shown in earlier sections of this Report, several approaches have been identified as a means of permitting access to the limited spectrum. This section evaluates the various approaches in terms of system viability and the three fundamental criteria enumerated above. The cases considered include:

- Full Band Interference Sharing
- Band Segmentation by Access Technology (8.25/8.25)
- Band Segmentation by Number of Applicants (1/n)
- Band Segmentation by Channelization (1.25 MHz)
- Full Band/Polarization Segmentation Sharing

8.2.1. The following Table 8.1 compares each of the band sharing approaches discussed in this Report under the three critical criteria described in Section 8.1 above.

TABLE 8.1

CRITICAL CRITERIA	APPROACH				
	Full Band Interference Sharing	**Band Segment. By Access Technology**[2/]	**Band Segmentation 1/N**[2/]	**Band Segmentation Channelization**[2/]	**Full Band/ Polarization Segmentation**[2/]
Number of Economically Viable Applicants[1/]	5	1-3(?)	5	Unknown (?)	6
Aggregate Capacity[3/]	11,436	CDMA: 5,718[4/] TDMA: 3,852[5/] Total: 9,570	9,530[4/]	Unknown (?)	CDMA: 12,500 TDMA: 3,600 Total: 16,100
Facilitation of new entrants	Greatest	Least	Moderate	Moderate	Good

1/ Assumes maximum number is the current number of pending applicants, i.e., six (6).

2/ Assumes CMDA applicants aggregate band assignments and share on full-band interference basis.

3/ Capacity (given in duplex voice channels) is based upon data in Section 5.1.5.2 (Case 4) and Section 5.5; it assumes 16.5 MHz L-Band and 6 dB cross polar isolation. The data assumes for CDMA applicants an average of 20 beams. If 60 beams were used (as Motorola proposes), the capacity shown here for CDMA would triple.

4/ Some of this capacity is unrealizable due to non-viability of some of the respective systems.

5/ The Iridium capacity used in this analysis (as provided by Motorola) is overstated. As Annex 5.5 shows, the capacity is only 1,292 channels.

8.2.2. From Table 8.1 IWG1 concludes that both the Band Segmentation by Access Technology and Band Segmentation by Channelization approaches are unacceptable as means for licensing MSS systems, albeit for differing reasons.

8.2.2.1. An approach based upon Band Segmentation by Access Technology is inequitable, leads to the fewest potential number of viable operators, has the lowest total voice channel capacity

serving CONUS, and is the most difficult to coordinate internationally.

The Band Segmentation by Access Technology approach, whereby a single FDMA or FDMA/TDMA applicant is assigned 8.25 MHz in the upper portion of the L-band, and the remaining five CDMA applicants the lower 8.25 MHz, would appear to support viable operation by the FDMA/TDMA applicant, which would achieve some 3,800 circuits over CONUS. The remaining five applicants would have to share spectrum (most of which is subject to inter-service sharing restrictions (see Sections 1.3 and 7) which, at best, would yield an average of only 6,000 circuits. This level of capacity is insufficient to enable two of the CDMA applicant systems to operate viably as currently proposed and is of questionable utility to the other three applicants, although it is possible that two applicants proposing smaller initial systems could commence viable operation under this approach. (Given this fact, total CDMA capacity will likely be reduced.) Under this approach, if two FDMA systems were to share the upper 8.25 MHz, the existing TDMA applicant's system (employing bi-directionality) would not be viable.

One significant difficulty with this approach is that CDMA systems are assigned that part of the L-band which requires accommodation of either the Radio Astronomy (1610.2-1613.8 MHz) and/or Aeronautical Radionavigation Services (1610-1616 or 1621 MHz). Thus, those systems will face the possible loss of capacity and/or greater system operational complexity and expense. (It has been suggested that one way to militate against this inequitable result is to assign each licensee its proportional allotment of spectrum from both the lower and higher portions of the L-band. It is difficult to assess at this time whether such an approach can be implemented and what practical complexities may arise from such a procedure.)

This band segmentation approach (supported only by Motorola) also raises the following difficulties:

(a) Initial assignment. Motorola's plan provides that the upper 8.25 Mhz should be assigned for TDMA operation in order to fit the needs of the characteristics of the Iridium system (i.e., desired use of secondary downlinks, desired power levels preclude use of S-band). A decision which accommodates the needs of only one applicant would be inequitable and not necessarily consistent with the public interest.

(b) Subsequent re-assignment. Because Motorola's band segmentation plan fixes the boundaries within which systems must operate, it has proposed to re-evaluate spectrum usage on a periodic basis, and re-assign spectrum based on demand and/or

usage. A formula would have to be devised in order to equitably re-assign to one system spectrum which had been previously assigned to another system. Considerable debate would be required in order to determine what formula would fairly characterize the conditions under which each system operates and how spectrum should be reallocated (potentially monthly) in the public interest. Also to be decided would be how frequently readjustments would be made and how an operating system would be required to curtail usage of segments which have been assigned to a newly operational system.

(c) Competition. Another problem with Motorola's band segmentation plan is that it would not promote competition. Only one applicant -- Motorola -- currently proposes to use TDMA operation, and so, once operational, would obtain a monopoly in the upper 8.25 MHz band, while potentially five licensees would be relegated to 8.25 in the lower half of the L-band. As demonstrated above, this plan would restrict to one or two the number of economically viable systems in each segment of the band, thereby reducing the total number of operating systems and thereby restrict competition.

(d) Equity. Given the issue raised in IWG2 with respect to the feasibility of using the 1610-1616 MHz band for MSS, due to the question of coordination with GLONASS, the Motorola band segmentation scheme is also inequitable. According to Motorola, CDMA operations would be restricted to operation in the 1610-1618.25 MHz band, which may potentially provide only 2.25 MHz for CDMA use.

(e) Public Interest. Based upon the capacity figures provided in Section 5, as summarized in Section 8.1, band segmentation would result in an inefficient use of the spectrum and therefore would be contrary to the public interest. Moreover, the advantage of CDMA sharing -- which allows more users per MHz due to multiple system sharing than a single system such as Motorola has proposed -- will be lost. Since the uplink spectrum will be limited for CDMA operation, the potential sharing of the "CDMA segment" would be truncated.

8.2.2.2. The Band Segmentation by Channelization approach is undesirable for other reasons. First, since the single FDMA/TDMA applicant cannot aggregate its channel assignment with others, and thus share a larger pool of spectrum resource, it will be able to obtain less than 590 circuits over CONUS. This would not permit an economically viable operation for this applicant.

One of the major difficulties with the channelization approach to band segmentation is that no applicant can be assured how much capacity will be available for growth since each is only assigned

a small segment of capacity when licensed (e.g., one or two channels). This may make it very difficult for some systems to meet their business plans and/or secure necessary financing to construct their systems.

In addition, it is likely the initial operating spectrum for the applicants will be in the upper portion of the band until the Glonass system can be reconfigured to operate below 1610 MHz. A band segmentation by channelization approach will disadvantage applicants that have designed their systems to operate over larger spread bandwidths. The smaller the amount of operational spectrum the less likely it is to develop a channelization plan which accommodates all applicants. No channelization plan gives the Iridium system sufficient spectrum for their operation.

8.2.3. On the other hand, this Report shows that Full Band Interference sharing is achievable based on a relatively simple set of "coordination interface" parameters related to spectral PFD and areal EIRP spectral density (see Sections 2 and 3), and that high capacities are possible, using realistic assessments of other factors. For example, Table 8.1 shows that under the Full Band Interference Sharing approach five applicants can readily enter the market sharing 12,200 circuits over CONUS. This is sufficient capacity to permit all five of the CDMA applicants to meet their business plans. (Section 6.2 of this Report shows that further capacity improvements are probable.)

Full band interference sharing also meets a number of other important criteria. Because each licensee would be authorized to operate in the entire L-band and S-band allocation, no evaluation of system designs would be required. Moreover, each licensee would bear any burden associated with the issue of how to accommodate existing services in the lower portion of the L-band and the S-band.

As is apparent from the presentations on its continuing development, CDMA technology represents the most flexible access technology available and adopting its use for the MSS/RDSS bands would allow future technical innovations to be utilized by all applicants. Moreover, because each applicant is allocated the entire 16.5 MHz of each band, full band interference sharing inherently avoids warehousing and more easily accommodates growth of individual systems.

Coordination procedures would be straightforward for both domestic and international environments. The CDMA proponents have already been able to agree on a approach to coordination which could be the foundation of interservice coordination once the systems are licensed. This approach also has the advantage of permitting expansion into other parts of the band (e.g., after

resolution of the Glonass sharing issue) without requiring any changes to the technical rules developed to facilitate sharing.

It should be noted that the Commission has already once adopted a full band sharing approach through CDMA for the bands at issue here. See Radio-Determination Satellite Service, 60 RR 2d 298 (1986). The advantages which made CDMA the technology of choice at that time are no less applicable now.

Based upon the foregoing, IWG1 believes that this approach presents the best means of meeting the Commission's goals.

8.2.4. Band Segmentation by Number of Applicants (1/n) -- if accompanied by a requirement that CDMA proponents aggregate their assigned band segments and share it on a Full Band Interference basis -- would appear to provide sufficient capacity to allow the CDMA applicants to operate viably, but would not permit the single FDMA/TDMA applicant to do so, as long as it operates in a bi-directional manner. For example, under a 1/n approach, the FDMA/TDMA applicant would receive an assignment of 2.75 MHz, which would yield it a capacity of only 1,284 circuits over CONUS, an amount which it has stated is insufficient to meet the costs of its system. Thus, as compared to Full Band Interference Sharing, this approach will yield the same number of operators (5), but sharing a lesser amount of total capacity.

8.2.5. Another option -- a hybrid full band/polarization segmentation approach -- would allow the maximum number of entrants. Because it uses polarization isolation to divide the spectrum, the single FDMA/TDMA applicant must remove bi-directional operation from its system architecture, a step the applicant has indicated it is not prepared to do. Nevertheless, if this applicant would alter its system design in this manner, over 10-15,000 channels over CONUS can be obtained, more than any other band sharing approach. Accordingly, IWG1 urges the Commission to adopt this approach if the Full Band Interference Sharing option is not adopted for regulatory or other non-sharing reasons.

8.2.6. IWG1 wishes to note that of particular concern in all of these cases where the full band is broken down into segments is how future growth and new entrants (domestic or international) can be accommodated. In general, however, IWG1 concludes that the band segmentation approaches may result in the following disadvantages for the proposed systems: (1) increased complexity (and cost) of satellite systems wedged into smaller bandwidths; (2) lower overall capacity from increased interference as systems are made more complex to make up for less usable spectrum; (3) loss of capacity gain from multiple CDMA systems using the entire bandwidth; (4) spectrum warehousing in one segment because

multiple systems cannot reuse the entire bandwidth; and (5) reduced competition.

Also, band segmentation requires the use of guard bands which necessarily is wasteful of the spectrum dedicated to that purpose. In addition, a portion or all of the unmatched S-band may lie follow as a result of bi-directional operation by one applicant.

8.3. International Coordination Issues.

8.3.0. Resolution 46 adopted by the 1992 WARC specifies the international coordination process for non-geostationary MSS/RDSS satellite systems with other satellite systems and with other radio services in the 1610-1626.6 MHz and 2483.5-2500 MHz bands. The procedures are an extension of the current advance publication, coordination and notification procedures of Articles 11 and 13. The major difference in the application of Resolution 46 will be in the technical issues that will be raised in the coordination of non-geostationary satellite systems.

8.3.1. IWG1 concludes that it will be easier to effect the introduction of MSS systems by other countries and conclude international coordinations with U.S. systems if the FCC authorizes spread spectrum systems operating on a Full Band Interference sharing basis. This Full Band Interference sharing approach draws on the method for multiple RDSS systems operating in these bands on a co-coverage, co-frequency basis described in CCIR Report 1050. The Lower PFD and EIRP density bands of CDMA systems make coordination with other services in the band practical on a co-coverage and co-frequency basis. Moreover, coordination of CDMA systems with other satellite systems on the basis of a few generalized parameters would be much easier than coordination on the basis of complex schedules of frequency and beam activation and deactivation which would be required for the TDMA bidirectional system discussed below.

8.3.2. A TDMA bidirectional system is inherently difficult to coordinate with other such systems and with CDMA systems. Motorola claims that its TDMA bidirectional system can not share on a co-frequency, co-coverage basis with any other systems or services. There are two basic consequences of this bidirectional design. First, bidirectional FDMA/TDMA systems must have exclusive use of frequency bands on a world-wide basis because they cannot share with each other. Second, there are no practical means to mitigate interference in co-frequency, co-coverage cases, and so it is difficult, if not impossible, to resolve interference problems. Also, the effect of the secondary downlink on the primary MSS uplinks operating in a co-frequency,

non co-coverage basis needs to be quantified on a system-by-system basis.

The practical effects of these technical consequences is that significant operational difficulties, with attendant administrative burden on the FCC, will arise if the TDMA bidirectional system is licensed where an adjacent country authorizes any other MSS system. In such cases, gaps in service near the borders of a country in which the TDMA bidirectional system is authorized to operate are likely because of interference caused by the primary uplinks in the adjacent country to the secondary downlinks and because each secondary downlink beam must be shut down as soon as it touches the territory of a country where it is not authorized to operate. Also, the FCC will be required to protect primary uplinks operating in the U.S. from the effects of secondary downlinks licensed to operate in other areas of the world.

Thus, unless the TDMA bidirectional system has exclusive access to a band on a world-wide basis, the FCC will be involved in the development of coordination agreements based on specific beam and frequency activation and deactivation schedules for each pair of adjacent countries where this system and another dissimilar U.S. or foreign system provides service. Additional coordination complications will arise through interference caused by the secondary downlink to the satellite system of another country, particularly if the orbital altitude of another system is close to that of the system employing bi-directional operation.

8.3.3. The full band interference approach greatly simplifies international coordination, particularly where there are significant differences in system design parameters among U.S. and foreign systems. In large part, this is due to the lower power densities at which these systems are designed to operate and to the averaging effects of spread spectrum which mitigate the adverse impact of any individual instance of interference and allow gradual adjustment of parameters to balance the interference caused by varying traffic loads of different systems.

As discussed in Sections 2 and 3, coordination among CDMA systems is based on reaching agreement on a few basic technical operating constraints, analogous to the use of "generalized parameters" in the fixed satellite allotment plan. This would reduce coordination complexity and eliminate the need to negotiate coordination agreements on the basis of an extensive list of technical parameters. For Full Band Interference sharing, coordination can be focused on the negotiation of only an aggregate downlink PFD and an aggregate uplink areal EIRP density for all U.S. systems, which can then be allocated further among

U.S. system operators through a coordination process identical to the domestic coordination process. This approach to coordination is self-enforcing and less complex to regulate since the allocation of interference noise between systems, in terms of downlink PFD and uplink areal EIRP density, can be related to the traffic being carried over each system within each country. Moreover, there is no need to shut down beams as a satellite passes over a country it is not authorized to serve; the only requirement is to ensure that the PFD does not exceed the RR 2566 limits if coordination agreement is not reached on the slightly higher levels anticipated for current spread spectrum systems.

FCC involvement in coordination of systems operating on a Full Band Interference approach will therefore be much less than that for bi-directional FDMA/TDMA. The administrative burden of coordination can be even further reduced, and probably eliminated, if a future WARC adopts a modest increase in the PFD limit at 2483.5-2500 MHz to eliminate the need for any coordination of planned systems in the band.

8.3.4. In the case where the U.S. must coordinate with narrowband FDMA or FDMA/TDMA systems, some type of band segmentation may be required to accommodate incompatible systems from other administrations. If any band segmentation is required to accommodate a system from another administration, the band segments should be at one end of the spectrum or the other so that the U.S. systems are able to operate over a contiguous amount of spectrum. This will prevent any one U.S. MSS system from being severely disadvantaged and allow the U.S. systems to maximize the available channel capacity over the remaining portion of the spectrum.

8.4. General Conclusions and Recommendations.

IWG1 reaches the following conclusions and recommendations:

8.4.1. There is sufficient spectrum to accommodate all of the pending applicants with some adjustments to all currently proposed system designs and Celsat.

8.4.2. A resource allocation plan, whether allocating frequency segments, time slots, or interference power, should be based upon sound principles and avoid arbitrariness. A fundamentally important principle for resource allocation is the equitable treatment of licensees. Since MSS/RDSS is a new service, equity requires that each applicant receive equal access to the spectrum resource.

8.4.3. The best means of assigning the available spectrum resource among multiple systems is Full Band Interference

sharing. Such an approach is the most flexible and spectrum efficient, provides the greatest aggregate capacity, facilitates international coordination, promotes competition, and avoids inequitable assignment of different portions of the band with greater sharing constraints. This is the only approach that allows the pending applicants to share on a co-frequency, co-coverage basis with each other and with systems operated by other countries using CDMA and still permit entrance by Celsat. This approach also minimizes sharing problems with other services in the bands.

8.4.4. In principle, both geostationary and non-geostationary satellite systems can operate in the MSS bands on an interference sharing basis provided that system parameters are chosen appropriately. No restriction on the selection of orbit needs to be placed on applicants.

8.4.5. The Full Band Interference sharing approach can be extended to accommodate non-spread spectrum systems since FDMA/TDMA systems can be configured to operate in a manner that causes no more equivalent interference than a spread spectrum system, provided that it does not operate bi-directionally.

8.4.6. The FCC should not authorize the use of the secondary MSS downlink at 1613.8-1626.5 MHz because of potential interference to other U.S. satellite systems. Bi-directional satellite systems cannot share on a co-coverage, co-frequency basis with other satellite systems or with other radio services in the band, and no coordination should be required between secondary and primary services. The analysis has shown that the secondary downlink cannot operate on a non co-coverage, co-frequency basis with U.S. MSS uplinks using an interference sharing approach since it will cause a reduction in capacity for these systems.

8.4.7. The FCC should adopt rules that grant all pending applicants satisfying these recommendations authorizations to construct, launch and operate their proposed systems, subject to coordination among the immediate and future operators and the use of default values for certain critical parameters such as downlink PFD and uplink areal EIRP density.

8.4.8. The Report and Order adopting the rules recommended in Section 9 below shall specify the Default Values described in Section 2.1. above and provide as follows: "In order to insure compliance with the agreed upon, or default (as the case may be), values discussed above, all MSS licensees will cooperate with each other in good faith to resolve questions concerning alleged violations of the coordination agreement reached between them. Each licensee shall (1) make available to any other coordinating licensee raising such question, subject to an appropriate

confidentiality agreement, all pertinent technical data in the possession of such alleged offending licensee necessary to resolve such question, and (2) promptly undertake to alter its system operations as required to correct such violations as may have occurred."

8.4.9. In recognition of the substantial net increase in U.S. MSS capacity to be realized through the addition of yet another CDMA applicant such as Celsat and the incremental public benefit which would flow therefrom, and subject to the limitations and rights of current applicants under the cutoff rules, the IWG1 recommends that the Celsat system receive the fair consideration to which it is entitled as a new entrant when and if it chooses to formalize the work which it has done with respect to bandsharing in an FCC application.

9. PROPOSED TECHNICAL RULE PROVISIONS FOR THE MOBILE AND RADIODETERMINATION SATELLITE SERVICE.

The Committee proposes that the Commission adopt the following rules to implement the Committee's conclusions and recommendations.

9.1. Replace subsection (25) to Section 25.114(c) with the following:

(25) Applications for authorizations in the Mobile and Radiodetermination Satellite Service in the 1610-1626.5 MHz and 2483.5-2500 MHz bands shall also provide all information specified in § 25.141.

9.2. Modify Section 25.141 of the Commission's Rules to read as follows:

§ 25.141. Licensing Provisions For The Mobile and/or Radiodetermination Satellite Service in the 1610-1626.5 MHz and 2483.5-2500 MHz Bands.

(a) Space station application requirements. Each application for a space station license in the Mobile and/or Radiodetermination Satellite Service in the 1610-1626.5 MHz and/or 2483.5-2500 MHz bands shall describe in detail the proposed Mobile and/or Radiodetermination Satellite Service satellite system, setting forth all pertinent technical and operational aspects of the system, including its capability for providing radiodetermination service on a geographic basis, and the technical, legal and financial qualifications of the applicant. In particular, each applicant shall include the information specified in Section 25.114, except that applicants for non-geostationary Mobile and/or Radiodetermination Satellite Service systems, in lieu of providing the information concerning orbital locations requested in Section 25.114(c)(6), shall specify the number of space stations that will comprise its system and their orbital configuration, including the number of planes and their inclinations, altitude(s), argument(s) of perigee, service arc(s), and right ascension of ascending node(s). Applicants must also file information demonstrating compliance with all requirements of this section, specifically including information demonstrating that they will not cause harmful interference to any authorized or licensed Mobile and Radiodetermination Satellite Service system.

(b) User transceivers. Individual user transceivers will not be licensed. Service vendors may file blanket applications for transceiver units using FCC Form 493 and specifying the number of

units to be covered by the blanket license. FCC Form 430 should be submitted if not already on file in conjunction with other facilities licensed under this subpart. Each application must show that its user transceiver units will comply with the technical parameters of the satellite system(s) with which the units will communicate.

(c) Permissible communications. Stations in these bands shall provide both mobile and radiodetermination satellite communications services.

(d) Frequency assignment policies. Each satellite system authorized under this section will be assigned the entire allocated frequency bands on a non-exclusive basis. Coordination procedures and power limits as set forth in subsections (e) and (f) below shall be employed to avoid harmful interference with other satellite systems in these bands.

(e) Mobile and Radiodetermination satellite system coordination procedures.

(1) Licensees shall coordinate with other licensees to avoid harmful interference to Mobile and Radiodetermination satellite systems in these bands. During the coordination processes, licensees shall exchange relevant information and interference calculations, subject to appropriate confidentiality arrangements, and shall meet as necessary to negotiate in good faith to resolve potential interference problems. Coordination hereunder shall be a continuous process, taking into account changes in system parameters, traffic configuration, and other relevant factors. Existing MSS licensees shall coordinate with new MSS licensees as authorized by the Commission, and in the absence of agreement, the Default Values specified in the Commission's Report and Order in CC Docket [xx-xx] shall apply.

(2) Technical coordination in these bands is based on the equitable allocation of interference noise among systems sharing these bands. A non-spread spectrum system shall not cause a higher level of interference to a spread spectrum system, nor place any more restrictive constraints on the operations of a spread spectrum system, than that imposed by any other single spread spectrum system operating in the bands.

(3) Coordination agreements would typically be based on mutually agreed values of the following parameters of each system operating in the band:

(i) The maximum value of the downlink PFD at any point in the service area per system, averaged over an appropriate

period of time. Polarization effects shall be considered when calculating the maximum PFD.

(ii) The maximum aggregate EIRP density simultaneously radiated by all user terminals for a single system within the Continental United States averaged over an appropriate period of time.

(iii) Polarization;

(iv) Frequency plans;

(v) Code structures and associated cross correlation properties;

(vi) Antenna beam patterns; and

(vii) Signal burst structures.

(4) In the absence of mutual agreement during the coordination process referenced above, the operations of MSS/RDSS satellite systems licensed under this section will be limited to the default values of maximum downlink PFD spectral density and maximum EIRP areal spectral density established by the Commission in its Report and Order in CC Docket No. <xx-xx>, recognizing that such values may be subsequently modified by Commission order.

(f) License conditions. All authorization in these bands shall be subject to the following conditions:

[To Be Determined From IWG2]

[IN THE EVENT THAT THE COMMISSION DECIDES TO ALLOW FOR SECONDARY, BI-DIRECTIONAL OPERATIONS IN THE 1613.8-1626.5 MHz BAND, SUBSECTION (g), AS FOLLOWS, WOULD BE ADDED]

(g) Downlink operations in the 1613.8-1626.5 MHz band.

Use of the 1613.8-1626.5 MHz band for space-to-Earth transmission is authorized on a secondary basis as defined in § 2.104(d)(4) and § 2.105(c)(3) of the Commission's Rules. Authorizations to conduct such space-to-Earth transmissions shall be subject to the following conditions:

(1) Any secondary usage of the 1613.8-1626.5 MHz band shall not reduce the capacity of any primary user of the band.

(2) The transmitting space station EIRP density shall be below (TBD) for transmissions not impinging on the earth in order to avoid harmful interference into primary uplink services;

(3) The EIRP of the main lobe downlink transmission shall be limited so as to include the effects due to specular reflections from the earth to comply with paragraph (1) of this subsection (g);

(4) Space-to-Earth transmissions in any space station antenna beam shall cease whenever there is a direct line-of-sight coupling with a receiving beam on another satellite in the band;

(5) Receiving earth stations in this band cannot claim protection from harmful interference from, nor otherwise place operating constraints on, transmitting earth stations operating in the band; and

(6) Operation of such downlinks shall cease immediately upon notification of harmful interference being caused to licensed uplink operations in the band.

9.3. Amend Section 25.202(f) by inserting the following in the introductory paragraph:

(f) Emission limitations. Except as specified in subsections (g) and (h), the mean power of emissions shall be attenuated below the mean output power of the transmitter in accordance with the following schedule:

9.4. Amend Section 25.202 by adding the following new subsection:

(g) Emmission limitations in the 1610.1626.5 MHz band, Earth stations. The mean power of emissions shall be attenuated below an amount equal to the mean output power of the transmitter times the fraction, 4 kHz divided by the authorized bandwidth, in accordance with the following schedule:

(1) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 50 percent (but at least 2.0 kHz) up to and including 150 percent of the authorized bandwidth: 26dB;

(2) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 150 percent up to and including 250 percent of the authorized bandwidth: 38 dB;

(3) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 250 percent of the authorized bandwidth: 45 dB;

(4) In any event, when an emission outside of the authorized bandwidth causes harmful interference, the Commission

may, at its discretion, require greater attenuation than specified in paragraphs (g)(1), (2) and (3) of this section.

(5) For the purposes of paragraph (g), the authorized bandwidth is the larger of the occupied bandwidth (the 99 percent power bandwidth) or the necessary bandwidth of the transmitted signal.

(6) Upon a showing that the operation of the station will not cause harmful interference to other systems or services or that the-of-band PSD is below coordination and interference values, the limits of Sections (g)(1), (2) and (3) of this Section shall not apply.

9.5. Amend Section 25.202 by redesignating current subsection (h) as (i) and adding the following new subsection:

(h) Emission limitations in the 1613.8-1626.5 MHz and 2483.5-2500 MHz bands, space stations. The mean power of emissions shall be attenuated below an amount equal to the maximum for any center frequency of the in-band mean power measured in a 4 kHz bandwidth in accordance with the following schedule:

(1) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 50 percent (but at least 2.0 kHz) up to and including 150 percent of the authorized bandwidth: 25 dB;

(2) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 150 percent up to and including 300 percent of the authorized bandwidth: 35 dB;

(3) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 300 percent of the authorized bandwidth: 43 dB;

(4) In any event, when an emission outside of the authorized bandwidth causes harmful interference, the Commission may, at its discretion, require greater attenuation than specified in paragraphs (h)(1), (2), and (3) of this section.

(5) For the purposes of paragraph (h) the authorized bandwidth is the larger of the occupied bandwidth (the 99 percent power bandwidth) or the necessary bandwidth of the transmitted signal.

(6) Upon a showing that the operation of the station will not cause harmful interference to other systems or services or that the out-of-band PSD is below coordination and interference values, the limits of Sections (g)(1), (2) and (3) of this Section shall not apply.

Attachment 2 to
IWG1 Report (Annex 1)
MSSAC-41.7 (Final)
IWG1-85 (Final)

REPORT OF

MOTOROLA

ON
BAND SEGMENTATION
SHARING

TO
WORKING GROUP 1
OF THE
ABOVE 1 GHz
NEGOTIATED RULEMAKING COMMITTEE

APRIL 6, 1993

EXECUTIVE SUMMARY

BACKGROUND

This report by Motorola Satellite Communications, Inc. ("Motorola") on band segmentation sharing in the 1610-1626.5 MHz and 2483.5-2500 MHz bands is presented to Informal Working Group 1 ("IWG1") for its consideration in preparing a summary report to the full Committee. At the IWG1 meeting on April 1, 1993, final agreement was reached on text for several sections of this report (Sections 1, 2, 3, 6 and 7). With respect to the remaining sections (Sections 4, 5, 8, and 9), this report reflects the views of Motorola. As a proponent of FDMA/TDMA modulation and band segmentation, Motorola's views on the issues addressed in these sections of the report differ significantly from the views of proponents of full band interference sharing. Motorola does not concur with parallel sections of the report submitted by the proponents of that alternative sharing approach.

The principal conclusions of this report are as follows:

(1) Motorola's band segmentation plan is far superior to the CDMA applicants' full band interference sharing plan because:

(i) It allows the two access technologies proposed by the applicants to proceed and compete in the marketplace for customers and financing, whereas the CDMA full band sharing proposal would not allow the Iridium™ system to operate using FDMA/TDMA on a bidirectional basis;

(ii) It allows the two fundamentally different visions of the MSS marketplace to develop. Motorola intends to serve primarily handheld portable terminals located anywhere in the world and under most shadowed and fading conditions, whereas the CDMA applicants cannot provide the same level of service because of the interference sharing rule and their lack of coverage/diversity of many

regions of the world including several states and U.S. territories;

(iii) It is easy to administer and would not require the FCC to micro-manage the coordination process;

(iv) It does not mandate a worldwide standard for LEO MSS systems and would result in greater flexibility in the international coordination process. A full band sharing plan can only accommodate foreign non-CDMA systems by segmenting the band;

(2) There are serious risks and limitations associated with a CDMA full band interference sharing approach which will have a significant impact on CDMA system capacity and performance. These risks and limitations include:

(i) Substantial ambient noise levels in the S-band from ISM devices (primarily microwave ovens) exceeding the thermal noise of the receivers which will prevent MSS operations in many urban and other populated areas;

(ii) Limitations on the dynamic range of handsets which will cause serious degradation of service or substantially reduced system capacities;

(iii) A requirement to use path satellite diversity which would approximately double the number of satellites required for worldwide coverage;

(iv) As additional systems share the spectrum, fade margin will be reduced resulting in either significant loss in capacity if service quality is maintained or a reduction in service quality (e.g., higher dropped call rates);

(v) Difficulties in international coordination with other CDMA, FDMA, and FDMA/TDMA systems proposed by foreign countries. A full band interference sharing plan